K-411

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MSCPH-501

Mathematical Physics

M.Sc. Physics (MSCPH)

1st Semester Examination, 2023 (Dec.)

Time : 2 Hours] **Max. Marks : 70**

Note : This paper is of Seventy (70) marks divided into two (02) Sections A and B. Attempt the questions contained in these sections according to the detailed instructions given therein. Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

SECTION–A

(Long Answer Type Questions)

Note : Section 'A' contains Five (05) long answer type questions of Nineteen (19) marks each. Learners are required to answer any Two (02) questions only.

(2×19=38)

1. (a) Determine the poles and the residue at each pole of the function :

$$f(z) = \frac{z^2}{(z-1)^2\,(z+2)}$$

(b) Show that the function $z\,|z|$ is not analytic anywhere.

2. Define the covariant and contravariant tensors and discuss the contraction and extension of the rank of tensors.

3. Describe heat equation in two and three dimensions.

4. (a) Explain orthogonality relation and generating function of Legendre's differential equation.

(b) If $J_n(x)$ is a Bessel function of the first kind of order w, prove that

$$\frac{d}{dx}\,[x^w\,J_n(x)] = x^w\,J_{n-1}\,(x)$$

5. Show that the fourier transform of a Gaussian function is also Gaussian in the corresponding fourier space.

SECTION–B

(Short Answer Type Questions)

Note : Section 'B' contains Eight (08) short answer type questions of Eight (08) marks each. Learners are required to answer any Four (04) questions only. (4×8=32)

1. State an explain Cauchy residues theoram.

2. What is a metric tensor and express it as a sum of a symmetric and skew symmetric tensors.

3. Show that :

$$\int x\, \mathrm{J}_0^2(x)dx = \frac{1}{2}x^2[\mathrm{J}_0^2(x) + \mathrm{J}_1^2(x)].$$

4. Prove the orthogonality of the Hermite polynomials :

$$\int_{-\infty}^{\infty} e^{-x^2} \mathrm{H}_m(x)\, \mathrm{H}_n(x)dx = 0, \quad m \neq n.$$

5. Solve the differential equation :

$2y'' + 5y' = e^{-2t}$; $y(0) = 1$; $y'(0) = 1$

using laplace transforms.

6. Find the Fourier transform of the function :

$$f(t) = \begin{cases} 0 & t < 0; \\ e^{-\alpha t} & t \geq 0; \end{cases} \quad \alpha > 0$$

7. Find rodrigue's formula for Legendre's polynomials.

8. Describe recurrence formula for $H_n(x)$ and to show that $H_n(x)$ is a solution of Hermite equation.